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How State Academies of Science May Encourage Scientific Endeavor among High-school Students: LOUIS A. ASTELL 445

The Production of Fever in Man by Short Radio Waves: DR. CHARLES M. CARPENTER and ALBERT B. PAGE 450

Scientific Events:
The Zoological Society of London; Assignment of Patent Rights to the St. Louis University School of Medicine; The Placement Service of the Federation of American Societies for Experimental Biology; Radio Talks; The Josiah Macy Junior Foundation 452

Scientific Notes and News 455

Discussion:
Sanity in Nomenclature: DR. H. A. GLEASON. *Wegener Hypothesis:* DR. WILLIAM BOWIE. *Zoopharmacology and Phytopharmacology:* DR. EDWIN H. SHAW, JR. *Teredolithus, a New Collective Group Name:* DR. PAUL BARTSCH. *Discovery of Phosphorus Fixing Compound in the Soil:* DR. A. H. MEYER. *The Banana in Early Books:* DR. PHILIP R. WHITE. *The Color-blindness of Indians:* PROFESSOR T. R. GARTH. *The Presidency of the British Association:* DR. A. F. HUNTER 458

Scientific Books:
Peterfi's Methodik der wissenschaftlichen Biologie: CHARLES A. KOFOID 462

Scientific Apparatus and Laboratory Methods:
An Electromagnetic Pump: DR. HEINZ ROSENBERGER. *A Method of Securing Marine Invertebrates:* PROFESSOR THOMAS HUME BISSONNETTE 463

Special Articles:
Determination of Polymerization of Some Polymer Formaldehydes by X-ray Methods: DR. EMIL OTT. *Turning of the Sperm in the Acridian Follicle:* PROFESSOR W. J. BAUMGARTNER 465

Science News x

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HOW STATE ACADEMIES OF SCIENCE MAY ENCOURAGE SCIENTIFIC ENDEAVOR AMONG HIGH-SCHOOL STUDENTS[1]

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I SHALL present four aspects of the problem of encouraging scientific endeavor among high-school students: a glimpse of the trends of the high-school curriculum as they bear upon proposals for cooperation by the state academies of science; an outline of the efforts of the Illinois State Academy of Science to encourage scientific endeavor among high-school students; a statement, as requested, of personal experience related to science clubs, and suggestions as to possible benefits if other state academies of science develop similar projects in their high schools.

Concerning the curriculum, it is apparent that old subject-content, standards, methods and results are not entirely satisfactory. Here, as elsewhere, philosophic and scientific studies are producing change. One who has been called "the greatest educational leader of our time, and perhaps all time,"[2] says in stating his theory[3] that the life of the school is to be

[1] This paper has been condensed from the paper read before the representatives of the State Academies of Science meeting with the American Association for the Advancement of Science, Des Moines, Iowa, December 27, 1929. The representatives voted to request the chairman of the American Association committee on the place of science in education to cooperate in revision and in arranging for the publication and distribution of the paper. Copies of this paper may be secured from the office of the permanent secretary of the American Association for the Advancement of Science, Smithsonian Institution, Washington, D. C., or from the chairman of the association committee on the place of science in education, 433 West 123rd Street, New York City.

[2] R. A. Kent, "Leadership," *Phi Delta Kappan*, XII, 2: 40, August, 1929.

[3] John Dewey, "School and Society," p. 11, University of Chicago Press, 1899.

active, not passive; that the children are to work, not merely to listen, that the curriculum is to be organized around the chief impulses, which are the social instinct of the children, the constructive impulse, the expressive instinct and the impulse toward inquiry or finding out things. So far as the average high school has learned to make use of these impulses, it has been through the so-called extracurricular activities.[4] McKown says: "Extra-curricular activities must be built upon the broad principle that the school is a laboratory for citizenship, and whenever possible the situation in the school should resemble the situation which the future citizen will face." Such activities should be recognized and made a regular part of school life and work.

The science club offers a master key to scientific endeavor among high-school students. The state academies can foster science clubs in high schools by offering the mutual advantages of affiliation between the clubs and the academies. From such affiliations each member of the junior organizations, through such association, may be led to sense the power that science is wielding. There are not less than four million students of high-school age available to organization and leadership. These four million and those to follow will need to know, more than the pupils before them needed to know, all that science can impart to them and open to them for their own opportunities.

The magnitude of the science club movement throughout the country was shown by Dr. H. A. Webb,[5] who compiled data on 146 science clubs in 28 states and found a total enrolment of 5,608 students. In the State of Illinois there are approximately 700 four-year high schools which are officially accredited or have applied for accrediting. Of these there are 290 which are on the approved list of the North Central Association of Colleges and Secondary Schools. The total enrolment of these 700 Illinois schools is approximately 270,000; the average enrolment is approximately 387. In those 700 schools, not less than 67,500 students are enrolled in science courses. In the average Illinois high school a minimum of 96 students is enrolled in science courses. Now, if each school should have one science club, 700 high schools would have 700 potential science clubs. Or, since the 290 four-year high schools bearing the approval of the North Central Association of Colleges and Secondary Schools represent the best that Illinois has in the matter of standards, the Illinois State Academy might reasonably anticipate affiliation of from 290 to 700 science clubs. The Illinois State Academy of Science began fostering and affiliating high-school science clubs in 1919. It has affiliated clubs from 18 different schools. If the number of years during which each club has maintained affiliation be added together, there are 51 year-units of high-school club affiliation with the Illinois State Academy of Science. It is believed that a similar program operating through all state academies of science would be possible. Organization, detailed information and wise stimulation were found to be essential prerequisites on the part of the academy. Character, initiative and other leadership qualities are essential requirements of the local sponsors. Cooperation is the chief essential to be contributed by the local school administrations.

The work of the science club should be a regular and important part of school life, and not an extra piece of work put in at the end of the day or week as an activity unrelated to school work.

The Illinois academy has affiliated scientific societies other than high-school clubs. These society affiliations may have definite relationships to the high-school clubs. They may have addresses or other programs of general interest. Invitations from the societies to the high-school clubs in the community or section of the city represent a salient method of stimulating interest in clubs of secondary schools. Also the affiliation of these societies represents one thing the academies may do toward adult education, which it seems must sometime involve the whole of our educational system. The tabulated data on these societies show that society organizations in terms of maintained affiliations are the more stable. This stabilizing and constant good influence is wholly desirable as far as the high-school science clubs are concerned.

Difficulties regarding high-school affiliations are due, in part, to the following causes:

In the development of the so-called non-academic subjects, including athletics, the classroom instructors lost much of their earlier influence in extracurricular activities. Discussion societies and dramatic clubs, which formerly represented the most activating type of extracurricular work, came to be of little consequence as a means of motivating the student in the average high school. This situation arose partly because the average instructor of academic subjects was not well prepared to match the influence of his personality and work against so many powerful factors outside the classroom. Then, there came to the high school hordes of children who did not possess a background of scholastic interest. It is a salutary thing that science, in continuously extending privileges to man's ability, is among the first in the academic field to use concerted action toward appreciation and in-

[4] Harry C. McKown, "Extracurricular Activities," p. 9, Macmillan, 1927.

[5] H. A. Webb, "Some First-hand Information concerning Science Clubs," *School Science and Mathematics*, 29: 273–76, March, 1929.

formation through such agencies as science clubs and societies.

Secondly, the science instructor must meet outside influence by offering genuine and lasting values to all those whom he expects to motivate. The instructor must be a salesman[6] of the highest order. With proper incentives and dependable working tools he will produce the desired results. These incentives and tools should be derived from at least three sources: the teachers' training course, teachers' conference meetings and state and national organizations. Interest on the part of science instructors is increasing. Requests for information of various kinds relative to club work have come from many states and from Canada. It is desired that the state academies work through these teachers' training courses and teachers' conferences. Such plans require time and tact for their development. The quality of the personnel of committees is essential to success of even carefully developed plans. Not only these state committees but also the local club sponsors are vitally important in the success of the movement.

At the Jacksonville meeting, J. L. Pricer,[7] then state secretary, concluded his report as follows:

> Education in science is so vital to the general welfare of every phase of science that it seems to me that every member of the academy should have some interest in the problems of science education in the secondary schools. Therefore, I believe that the academy should have a permanent committee of three on science education in the secondary schools. It should be the function of this committee to make annual reports to the academy on the status of secondary school science, and on occasion to call on the academy for cooperation and help in the solution of certain problems.

In 1922, the president was empowered to appoint a committee of five, to be called the committee on high-school science and clubs. This committee took the place of two former committees, the committee on secondary science and the committee on high-school clubs. This committee has separate chairmen for high-school science and for high-school science clubs. These chairmen work together with the whole committee on the various problems they have to consider. It is my opinion that the compact committee of those responsible for cooperation with high schools represents a very efficient arrangement. In 1926[8] the committee decided to confine its activities to presenting a series of programs in the high-school section of the annual academy program, for the purpose of encouraging the formation of science clubs. With the demonstration of more tangible values no clubs were lost during the next two years and there have been gains each year, until at the present time there are more clubs than at any time in the history of the movement. The Danville Science Club has held affiliation continuously for nine years. Last spring, for the annual meeting at Macomb, several car-loads of high-school delegates, bearing their scientific exhibits, traveled across the length and breadth of the state to enjoy the dynamic program arranged for them. This included a stirring lecture on the opportunities in science to-day by Professor B. S. Hopkins. There were films and reports on the activities of the various clubs, as well as judging of exhibits. The most stimulating feature of the business meeting was the adoption of a standardized pin and guard to be worn by the student members of all affiliated clubs in the state.[9] That evening, preceding the popular lecture, a chemistry play[10] by college students was presented through the courtesy of the Western Illinois State Teachers College. The privilege of taking six representative high-school delegates on that 450-mile trip to such an inspiring program represents an opportunity in leadership and service which is an outstanding thing in my teaching experience.[11] Out of the success of that trip has arisen the community project of providing for transportation for high-school delegates to the annual meeting of the academy.

To aid sponsors and clubs in organization as a step toward affiliation, the Illinois academy has authorized the preparation and distribution of literature. An eight-page printed pamphlet[12] has been useful. It contained a model constitution, sample programs, information on the significance of science and on the importance of affiliation with the academy. It also included addresses given by the committee members. One of the publications recommends automatic perpetuation of the club through the election of officers at the end of a year rather than at the beginning of the next year. If, then, there is the somewhat common change in sponsorship or administration the science club has a greater chance of surviving. Another practical suggestion is the development of a model constitution for the junior academy of science,

[6] A. L. Turnbull, "The First Great Salesman of Science," *Popular Science*, 109: 25, September, 1926.

[7] J. L. Pricer, "Secretary's Report," *Transactions of the Illinois State Academy of Science*, XII: 17, 1919.

[8] F. C. Phipps, "Report of Council Meeting," *Transactions of the Illinois State Academy of Science*, XIX: 11, 1926.

[9] L. A. Astell, "A Ritual and Other Devices for High-school Science Clubs," *School Science and Mathematics*, 27: 952–955, December, 1927.

[10] R. D. Billinger, "A Night in Alchemy," *Journal of Chemical Education*, 5: 715–24, June, 1928.

[11] L. A. Astell, "Fostering Science Clubs in the High School," *Journal of Chemical Education*, 6: 496–501, March, 1929.

[12] "A Message to High-school Science Teachers and Students of Illinois from the Committee on High-school Science and Clubs." The chairman of this committee was Dr. J. C. Hessler, of Knox College.

with provisions for state officers to be selected from the high-school students in affiliated clubs. Another suggestion is that detailed program outlines found to be successful because of their dynamic, educational and general values should be compiled and distributed together with program references in current literature.[13] The program data should include the names, sources and ratings of films, slide sets and film-slides used in connection with these programs. The average teacher will appreciate such carefully developed service. He will need to recognize, of course, the sociological importance of imitation as applied to the students' action. In the same manner he will need to take cognizance of the psychologically valuable principle of self-expression. And he must reckon with the pedagogically valuable advantage of student participation in the social events and consciousness of the surroundings. All these things need to be understood by the instructor, but he does not need to be a master in these fields nor does he need to have a personal library of special information in order to get good results.

The idea of fostering the spirit and methods of science through a knowledge of our great men of science has not been developed as fully as desired. Relatively few clubs at the present time have honored scientific achievement in this way. The requirement that candidates pass a written initiatory examination on the life of the chosen scientist whose name has been selected by the club is a valuable aid. The presentation of films or other types of visual aid materials regarding the life and work of the chosen scientist is another deserving method, particularly if accompanied by good talks. This year, on the night of "Light's Golden Jubilee," the Edisonian Science Club of West Chicago held its initiation. The formal part included slides and accompanying remarks concerning the great benefactor. Then, in the hush of anxious moments, the re-created voice of Edison, himself, as it was broadcasted from Fort Dearborn, swept into the auditorium. To have been initiated into this club on the fiftieth anniversary of the incandescent lamp is a memory to be treasured. Who could forget that privilege? What an incentive for emulating Edison's painstaking methods! What an urge for duplicating his production in any small part!

The academy can help further by placing the high-school club section of the academy's annual program at such time as to avoid conflicts with the important and popular features of the general program. The Illinois academy, for example, no longer has the club section meeting on Saturday morning, which is the time for the customary field trip. Another factor in the success of clubs is the lecture service. The constitutions I have used have required that the clubs bring or assist in bringing to the community at least one good scientific lecturer each year. No large amount of work has yet been done by the Illinois Academy of Science in the direction of free lecture service. Thus far the academies have discharged this function through the careful selection of speakers for the annual program. The appointment and endorsement annually of lecturers for high-school clubs at a minimum of expense to the individual club may become desirable. Even though the academy were to develop some means to defray a major portion of the expense, this seems more practical than calling for volunteers to give gratis lecture service. The high-school students would obtain further value from the idea that these lecturers represent the state academy with which their club is affiliated. On the same basis the lecturers should be able more effectively to encourage scientific endeavor in the youthful audiences.

Where the academies are unable to render lecture service to the affiliated clubs the following alternatives are offered. First, the academies can distribute gratuitously, or otherwise, such admirable reprints as Dr. Little's "The Fifth Estate." These reprints should be selected with a view toward utilization as student reports in the club programs. Such material is not commonly found in the average high-school library. Second, the academies can send out reference sheets on scientific lectures, which after all are to be found in considerable numbers[14] under conditions not difficult to meet by the average club. This has never been undertaken by the Illinois academy, but it is recognized as a practical and inexpensive service. The academies can encourage the clubs by distributing or listing references to novel, distinctive and purposeful initiation ceremonies.[15]

It will be noted that none of these suggestions entail extensive machinery on the part of the individual state academies. Nearly all the suggestions are already in practice in Illinois. Teachers perhaps are too often concerned with receiving rather than rendering service, but it seems that the psychology for obtaining useful affiliations is not greatly different from that of obtaining added club memberships, that is, by having the academy demonstrate its service to the affiliated clubs.

How does the principle of encouraging scientific endeavor among the high-school students through the

[13] "Program, Edisonian Science Club, West Chicago Community High School, West Chicago, Ill.," *School Science and Mathematics*, 29: 1929.

[14] The School Assembly Association, 1309 Kimball Building, Chicago, Illinois, and the Bureau of Commercial Economics, Department of Public Instruction, Washington, D. C., are examples.

[15] W. M. Lamar, "The Fraternity Initiation," A one-act burlesque, *Journal of Chemical Education*, 6: 2254–59, December, 1929; L. A. Astell, "Initiation Ceremony of the Edisonian Science Club," *School Science and Mathematics*, 28: 771–4, October, 1928.

state academies find application? First, there will be an application to a single student; then to the club as a whole as shown by a comparative outline of annual reports; then the work of certain progressive clubs will be presented; then the concluding remarks.

Some time ago, a boy was discovered making, voluntarily, day-by-day clipping record of Commander Byrd's work in the Antarctic. What school hasn't a boy who has been doing that! In conversation with the boy it was found that he had studied the North Pole achievement as completely as the libraries at his command permitted. These libraries were above the average on account of the environment and suburban location. The boy had made a study of the personal life of Commander Byrd. The teacher's opportunity for encouraging scientific endeavor was plainly shown. The idea of a "Pole to Pole" theme program came into being. Two reels of Commander Byrd's North Pole flight were located.[16] What audience would not thrill at the thought that before their eyes were reflected the very pictures that Byrd had taken during the flight, as the now-lamented Bennett piloted the plane known as the *Josephine Ford* above the barren and untracked wastes to a new victory for mankind? What history! What science! Another reel on Byrd's South Pole preparations was booked from a difference source.[17] The club boy was scheduled to give the half-hour feature-talk as part of the program. A local business man, who had lived in Alaska, was secured to add "native color." Only music and short readings were needed to add the final touch to a program worthy of the attention of any adult audience. What a privilege for the local club members and for the invited delegates from other high-school science clubs! What a feeling of assurance must have arisen in the minds of the club members' parents who were invited to attend this program! What more satisfactory way of encouraging scientific endeavor among high-school students and in the community!

Whatever the form of organization and the nature of the scientific work of the individual club, the end product should be an encouragement of scientific interest and endeavor which the student will not discontinue when he leaves the high school. This is true already, we believe, where delegates have gone to worth-while state academy programs; where these student delegates have their own junior academy organization with their own officers functioning under the senior academy and where the state academies are rendering definite assistance in the matter of organizing and operating the local high-school clubs.

If the efficient management of this detailed service on the part of each state academy appears to be too burdensome, or if there should be too much duplication by the different state academies, there might be a national director who would perform his duties in cooperation with the state chairmen of high-school science clubs. The permanent secretary of the American Association may have had something of this thought in mind a year ago to-day when he spoke of the economic aspects and increased efficiency of circularizing the science workers in each state through the Washington office. If such a director should secure detailed reports from the different state meetings he would possess the basic information necessary for service to each state academy. Useful reprints and other data could be sent to the state chairmen. Such a director's position should place him in command of suitable lecture service to be broadcasted through the courtesy of scientific organizations and companies for the benefit of the individual club organizations. The prestige of that position could be used to assist the affiliation of local high-school clubs and other local science organizations with the larger scientific bodies.

To summarize briefly. The state academies may encourage scientific endeavor among high-school students by establishing the necessary organization, by supplying detailed information and by developing momentum for science clubs as activities concerned with the fundamental academic subjects. The academies may promote this work through such specific actions as: (1) making the necessary constitutional changes of adult societies as well as high-school science clubs; (2) assisting in the development of a constitution for the junior academy; (3) by working through teacher-training courses in science, wherever offered; (4) by obtaining and utilizing to a maximum advantage the periods of time in scientific sections of district, state and national conferences and associations of teachers; (5) by preparing and distributing literature to the local clubs and schools; (6) by fostering the spirit and methods of science through an intimate knowledge of the men of science, and by the use of their names in identification of clubs; (7) by constructing the annual program of the state academy for the maximum benefit to the high-school delegates; (8) by supplying lecture service or reprints and other items of direct use in the local programs; (9) by encouraging the use of such devices as purposeful initiations, cards of credentials and standardized club pins, and (10) possibly sometime by the employment of a national director.

[16] Pathé Exchange, Inc., 35 West 45th St., New York City.

[17] Motion Picture Bureau, Y. M. C. A., 120 West 41st St., New York City, and 4829 South Kedzie St., Chicago, Illinois.

THE PRODUCTION OF FEVER IN MAN BY SHORT RADIO WAVES

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THE value of heat as a physical means of alleviating and curing disease has been emphasized constantly throughout the history of medicine. However, the significance of fever and its relation to the course of an infectious disease or to the healing of trauma has been debated often. It was believed that a rise in body temperature was only a sign of disease, as is pain, and, to establish the comfort of a patient, must be dissipated. Nevertheless, evidence has been accumulated during the last few years to show that a fever, disregarding hyperpyrexia of central origin, may be a phenomenon valuable to the diseased animal body. It is a very complex factor in which an increased amount of heat stored in the body is its chief manifestation. In this report it is impossible to tabulate all the facts substantiating the value of fever in the course of a disease, but we premise that it is a defensive mechanism for the body.

To raise the body temperature of laboratory animals such as mice, rats, guinea-pigs, rabbits, dogs, etc., is comparatively simple. Their mass is small and they are not so able to eliminate effectively an increased amount of heat as is man. They have a hairy coat and do not possess the great areas of sweat glands with such an extensive peripheral vascular bed. However, these factors may make such heatings more hazardous to the life of the animal.

Many investigators have described methods for heating the human body locally or generally. Local heating is easily accomplished, but since man's temperature-regulating mechanism is so efficient the elevation of a normal temperature is comparatively difficult. Because so much time has been required in the past to do this, the therapeutic application of artificial fevers has not been practical. Various physical methods have been employed. Hot water baths have been used successfully by Schamberg and Tseng[1] and by Mehrtens and Pouppirt.[2] Exposure of the body to artificially heated, dry and moist atmospheres has frequently been used in an attempt to raise the body temperature. Recently diathermic methods for producing artificial fevers have been developed. Nagelschmidt[3] as well as King and Cocke[4] have described special apparatus and methods for applying this energy for therapeutic purposes. The latter state that after a rise of one or two degrees during the first half hour or hour, they usually obtained a rise of .6 degrees F. for every fifteen minutes. While the physicist and those engaged in developing physical therapy have been conducting sueh experiments the bacteriologist and immunologist have also been studying this same problem. For a long time they have known that the injection of a protein, usually foreign, used as a diagnostic agent or as a therapeutic agent, will destroy the equilibrium between heat production and heat loss in the body and result in a fever with other symptoms characteristic of those observed in an acute infectious disease. Combinations of certain diseases occurring in the same individual, *i.e.*, an acute febrile disease with a chronic afebrile malady, sometimes resulted in an improvement or a cure of the latter. Such observations played an important rôle in Wagner von Jauregg's[5] development of the malaria treatment for paresis. Because of his success the study of the value of fever in an infectious disease syndrome is engaging the attention of many investigators. That the heat associated with the febrile phenomenon due to the injection of a protein is the factor that is responsible for the beneficial results is suggested by the favorable results obtained in the treatment of neurosyphilis by heat alone. The present methods that are used to establish fever in man are unsatisfactory in one respect or another. The injection of foreign proteins is hazardous because one is dealing with unknown factors and uncertain quantities. The use of Plasmodium malariae or spirochaetes for the treatment of general paresis often fails because of the danger concerned with the administration of a living virus and because of a failure to infect immune individuals. The physical methods employed are time-consuming, difficult of application, not easily controlled and, to a certain degree, dangerous.

Since the observation of Dr. W. R. Whitney, director of the research laboratories of the General Electric Company, that there is an elevation of the body temperature of men working in the field of a short wave radio transmitter, considerable experimental work has been undertaken to adapt this energy for producing artificial fevers. Hosmer[6] has reported

[1] Schamberg and Tseng, *Am. J. of Syphilis*, 11: 337, 1927.

[2] Mehrtens and Pouppirt, *Arch. Neurol. and Psych.*, 22: 700, 1929.

[3] F. Nagelschmidt, *Deutsch. Med. Wchnr.*, 54: 2102, 1928.

[4] King and Cocke, *Southern Medical Journal*, 23: 222, 1930.

[5] J. Wagner-Jauregg, *Psych.-Neurol. Wchnr.*, 20: 132, 1918.

[6] H. Hosmer, SCIENCE, 68: 325, 1928.

these heating effects on salt solutions of various concentrations and on small laboratory animals. She determined that this is a method for producing in animals any degree of fever at will without the introduction of foreign substances. The heat is produced directly within the animal body, as occurs in the course of a fever due to an infectious disease. This constitutes a method for internal heating in which the heat is generated in the organs of the body as rapidly as in the body walls, but because of the greater heat loss at the periphery the temperature of the internal tissues rises more rapidly.

During the last two years special types of apparatus have been designed by the research laboratories of the General Electric Company and used experimentally in an endeavor to cause a fever in man rapidly without great discomfort to the patient and to a degree high enough to be of value. The equipment used in our experiments has been constructed on the same principle as a short wave radio transmitter, with the exception that the energy is concentrated between two condenser plates instead of being directed from an aerial. The heater consists of a vacuum tube oscillator and a full wave rectifier that supplies the high voltage for the oscillator. The high frequency oscillator is composed of two 500 watt radiotrons operating at a frequency of from 10,000 to 14,000 kilocycles, the output of which is concentrated between two plates. The rectifier is an oil immersed transformer having a 7,000 volt secondary and feeding two half-wave, hot cathode, mercury vapor tubes. In conjunction with a filter system this unit furnishes the 3,000 volt D. C. plate supply for the oscillator. An auto-transformer is connected on the primary circuit of the high voltage transformer to provide plate voltage regulation.

The condenser plates are of aluminum, 28″ by 18″ by ⅛″, and are covered with hard rubber plates 30″ by 20″ by ¼″ to prevent arcing should the patient or attendant come in contact with the plates. In this field of undamped waves between the plates there is a rapid alternation of 3,000 volts drop of potential. We have obtained our greatest heating from the use of a 30 meter wave that oscillated 10,000,000 times per second between the plates. We have used wavelengths of 6, 15 and 18 meters, but they have not heated the body so effectively with the oscillator described.

The patient is suspended on interlaced cotton tapes stretched across a wooden frame 76″ by 28″ made of two by sixes. The under surface of the frame is covered with celotex one half inch thick, forming an air chamber beneath the body. A celotex cover of similar thickness, 8 inches high and one foot shorter than the frame, is fitted over it so that the head of the patient projects through an opening at one end. Thus there is formed a fairly tight air chamber around the body as it lies on the tapes. The patient rests on his back and the plates are placed at each side of the celotex box, so that the waves oscillate through the body from one side to the other. The plate distance can be varied, but as a rule has been kept at 30 inches. Two small hair driers are placed in openings at the foot, one above and one below, to circulate hot air around the body. These decrease heat loss and equalize the humidity throughout the enclosed atmosphere.

By applying the plates in this manner and by enclosing the body, it is heated rapidly without causing great discomfort to the patient. We have raised the normal rectal temperature of 99.6 degrees F. to 104 degrees F. and 105 degrees F. in from sixty to eighty minutes. In one instance a temperature of 106.5 degrees F. was recorded. Higher temperatures may be obtained easily with the apparatus employed, but, because of our limited experience, we have proceeded cautiously. When the desired temperature is reached it may be maintained in several ways: First, by decreasing the voltage; second, by increasing plate distance; third, by employing only the hot air blowers.

The temperature recedes very slowly to normal if the patient is allowed to remain in the box or if he is removed from the box and wrapped in heated, heavy woolen blankets, which is more comfortable for him. There is, of course, an increase in rate of pulse and respiration which, in general, corresponds to the rise in temperature. The patients begin to show hyperpnea at 104 degrees F., which becomes greater as the high temperature is prolonged. Occasionally one states that he feels nauseated or that his head aches. The systolic and diastolic blood pressure is decreased when high temperatures are produced. On the whole, patients do not appear to be greatly distressed or fatigued when the maximum temperature is maintained for one hour and then allowed to return to normal while the patient is well blanketed. We believe that the condition of our patients after treatment is much more satisfactory than that reported by investigators who have used other methods to produce artificial fevers.

We have also placed the plates above and below the body so that, as the patient lay on his back, the waves were oscillating from front to back and *vice versa,* but we were not successful because of peripheral burns from arcing. Various other methods to prevent heat loss from the body during the exposure, and to absorb the sweat, have been tried by us, but each has failed. Temperatures of 101 degrees F., and occasionally 102 degrees F., were attained, but as soon as there was excessive sweating, burning of the skin occurred, caused by the radio waves concentrating and

arcing through a drop of sweat. The burns apparently were due to the heat from the arc as well as to the drops of sweat that were heated by the arcing.

Although it is possible to heat the body in the enclosed celotex box by the use of the short radio waves alone, time was saved by using the hot air blowers. The circulation of the hot air around the body prevented some heat loss because the air in the enclosed chamber rose from room temperature to 122 degrees F. in twenty minutes. The maximum temperature of the air in box at any time was 131 degrees F. The circulation of the air apparently keeps the humidity throughout the atmosphere in the chamber more uniform. Sweating occurred under these conditions, but the circulating hot air helped to prevent arcing and burning.

Although we are able to produce successfully artificial fevers with the radio waves as described, we realize that the equipment used and the method for applying this form of energy to heat the body can be greatly improved, and this is rapidly being done. Various theories explaining the rise of temperature of the body when exposed to short radio waves have been discussed by Carpenter and Boak[7] in another report. We believe that the development of heat is due to the resistance of the body to the conduction of current between the surfaces adjacent to the opposed plates. At each alternation of polarity of the plates the corresponding polarities are induced upon the adjacent boundaries of the interposed body and current is conducted through the material for a brief interval. The heating of solutions similar to the blood serum is dependent directly upon their electrical resistance. It has been shown that dilute solutions of different salts when of the same electrical resistance exhibit practically identical heating effects. In this report, however, we have concerned ourselves primarily with a method for raising the body temperature. Through the cooperation of Drs. D. Glen Smith and R. A. McTaggart, of Schenectady, New York, we have been able to study the effect of such heatings on patients suffering from various diseases. The use of therapeutic fevers is still in the experimental stage, but they have great possibilities if our conception of the significance of a febrile reaction is correct. We have studied the effect of fevers produced by short radio waves on various laboratory animals and on twenty-five patients, and thus far we have failed to observe any objectionable effect unless extremely high temperatures are maintained for long periods. We have proceeded, of course, with caution, and have followed closely the variations in body temperature, blood pressure, the pulse and respiration. The use of such a method demands conservatism and sound judgment because of the comparatively short time it has been studied. However, we are of the opinion that, because of the practicality of this method of heating, it may be of value not only to the clinician, but also to the physiologist, the biochemist and the bacteriologist.

Studies of infectious diseases in laboratory animals that will be reported elsewhere lead us to believe that two desirable effects are obtained by raising the body temperature. First, the increased heat within the body makes a less favorable environment for the multiplication of a virus. Second, the heat increases the rate of those chemical processes concerned with the development of immunity and with the general defense mechanism of the body against infectious agents.

We are grateful to Dr. W. R. Whitney, director of research of the General Electric Company, and to Mr. K. C. DeWalt for their constant help and suggestions, and for the apparatus used in this work. We thank the staff of the Ellis Hospital, Schenectady, New York, for their cooperation.

[7] Carpenter and Boak, to be published in *Am. J. of Syphilis.*

SCIENTIFIC EVENTS

THE ZOOLOGICAL SOCIETY OF LONDON

THE London *Times* reports that the one hundred and first annual report of the Zoological Society of London, issued to fellows in anticipation of the general meeting on April 29, contains an appendix describing the centenary celebrations held last year. The addresses of the president on the general history of the society, and of the secretary on the scientific history, and the speeches of congratulation delivered by the chief delegates of other societies are printed in full. A list of the delegates who attended the celebrations and accounts of the dinner, at which the Prince of Wales was the chief guest, of the garden party attended by over 8,000 fellows and their friends, and of the dinner to the staff are given.

The body of the report, as usual, describes the progress of the society. The total assets amounted to £171,571, an increase of nearly £30,000 on the preceding year, but the liabilities were increased by £44,673, due almost entirely to a bank loan to defray the cost of the new refreshment rooms. On account of the tenure of the gardens, the value of buildings erected by the society can not be included in the assets. The income was £7,000 and the expenditure £5,000 less than in 1928. Rent, rates, income-tax and insurance cost over £5,000, provisions for the animals £15,500,

scientific work, including the library and the cost of publications, cost nearly £10,000. The admission fees and subscriptions of fellows amounted to over £24,000, the income from gate-money was nearly £66,000, from the aquarium over £16,000, and the refreshment-room profits were nearly £17,500.

The pathologist reports that there was a notable decrease in the incidence of tuberculosis in mammals and birds since the construction of the new Monkey House and the Bird House. It is noted that, although special attention was given to cases of disease among parrots, there was no case of psittacosis during the year and no outbreak of epizootic disease in any of the aviaries. On the other hand, an acute and rapidly fatal outbreak of enteritis, peculiar to Felidae and known as "cat distemper," occurred during August and September.

Considering the limited accommodation, there was a good deal of breeding. Three lions, six wolves, five foxes, a baboon, a yak, an American bison, a mountain zebra, a Bactrian camel, a Mongolian wild horse, a kiang, five deer, five antelopes, seven mouflon, seven thar, five Barbary sheep, three ibex, a beaver, a fruit-bat, as well as many smaller mammals, were bred and reared. The experimental breeding of budgerigars was continued, and 229 were bred and reared, including 86 of the blue and nine of the cobalt varieties. A large number of pheasants and some wild turkeys and geese were bred on the society's estate at Whipsnade.

ASSIGNMENT OF PATENT RIGHTS TO THE ST. LOUIS UNIVERSITY SCHOOL OF MEDICINE

THE announcement by Dr. E. A. Doisy at the thirteenth annual Physiological Congress in August, 1929, of the isolation of a follicular hormone has given rise to so many personal problems for Dr. Doisy and so many administrative problems for St. Louis University that effective measures had to be devised for dealing with them. Quack remedies of various kinds have quoted their potencies in Allen-Doisy rat units and have used the discovery of the "sex remedy" in various entirely unjustifiable advertising appeals. In at least one case, the university was forced either to enter a disclaimer or to protect its good name by still more stringent measures. In the interest of public health, ethical advertising and recognized standards in pharmaceutical manufacture, the president of St. Louis University has created a committee to be known as the Committee on Grants for Research, composed of the dean of the School of Medicine, the associate dean and the professor of biochemistry, to deal with full power with the various questions arising out of the situation.

On February 7, Dr. Doisy and his coworkers, Clement D. Veler and Sidney A. Thayer, had assigned to St. Louis University any patent rights which may be thought wise to secure in order that the difficulties just enumerated might be properly met. The terms of the donation provide that the eventual income, if any, is to be used entirely for the prosecution of research in the School of Medicine; any funds accruing are to be administered as the other funds of the School of Medicine subject to the general financial policies of the university.

The president of the university, in accepting this donation, committed to the newly established Committee on Grants for Research the administration of all contractual or other relationships which may arise within the university or out of it from the newly isolated product. He further empowered the committee, subject to the general university administration, to allot its income in accordance with the wishes of the donors and to administer a testing laboratory for ensuring a uniform and a dependable product.

The Council on Chemistry and Pharmacy of the American Medical Association recognized Dr. Doisy's right to name the newly isolated compound and has approved of the name "Theelin" for this follicular hormone. The Committee on Grants for Research has completed arrangements with a reputable commercial house manufacturing biological products. By the terms of the agreement, provision is made that all developments in the preparation of "Theelin," its clinical applications and the discovery of its properties must be shared alike by the university, on the one hand, and the licensee or licensees under the patent rights, on the other. In effect, therefore, cooperative research by all those interested in the manufacture and sale of the product is assured.

The one manufacturing company which has thus far been licensed will enjoy the exclusive right in the United States for the manufacture and sale for eighteen months. After that period, however, the patent rights are not restricted and other firms may be given license to manufacture and distribute under the same restrictions under which the first licensee is operating. The fullest liberty of publication is assured by the terms of the agreement. Moreover, all licensees will be required to submit their products to the testing laboratory of the university. It is the intention of the university to publish the various documents in regard to these arrangements in a special bulletin.

THE PLACEMENT SERVICE OF THE FEDERATION OF AMERICAN SOCIETIES FOR EXPERIMENTAL BIOLOGY

SOME ten years ago the Federation of American Societies for Experimental Biology, comprising the American Physiological Society, the Biochemical So-

ciety, the Pharmacological Society and the Society of Experimental Pathology, established a Placement Service, the function of which was to act as a medium of communication between those seeking positions in the above named sciences and institutions having vacancies in these departments. Previous to the establishment of this "Service" it was exceedingly difficult, for the young men especially, to make a change in location. In the first place they were just beginning their training, had perhaps taken their doctor's degree, but naturally they were not likely to hear of vacancies in other institutions. On the side of the universities it may be said that they often had vacancies, but they had difficulty in getting in touch with those who might be considered for an appointment. It was to remedy this situation that the service was established about ten years ago. During these intervening years it has been functioning in a quiet way, but with the wider knowledge of its existence its activities have increased considerably during the past three or four years.

At the present time, in addition to those who have already been placed, there are enrolled this year the names of forty who are desirous of a change of location. It is interesting to note the distribution of these forty among the various preclinical sciences. There are registered

Physiologists	14
Biochemists	20
Pharmacologists	5
Pathologist	1

These figures represent what may be called a typical distribution of the total registration as it has appeared for the past few years. The number of institutions represented on the active list at the present time is twenty-six. Twelve of these are inquiring for physiologists and ten for pharmacologists. It will be seen from these figures that the service is apparently filling a real need. It would be desirable, however, if more institutions would avail themselves of its help. It does little good for individuals to report that they are eligible for positions if institutions will not also report their vacancies. The peg is of little value unless there is a hole to fit it into.

It should be understood that the help of the service is open to non-members of the federation as well as to members and that there is no fee whatsoever charged for any help it may render. The executive officer of the Placement Service is Dr. C. W. Edmunds, Department of Pharmacology, University of Michigan, Ann Arbor, Michigan.

RADIO TALKS

THE National Broadcasting Company and the Press Service of the American Association are cooperating in a series of radio talks on scientific subjects which will be given over the National Broadcasting Company's network of stations covering the entire country.

These talks are offered under the auspices of a special board of sponsors, of which the membership is as follows: Dr. Robert A. Millikan, director of the Norman Bridge Laboratory, Pasadena, California, president of the association; Dr. Henry Fairfield Osborn, president of the American Museum of Natural History, New York; Professor J. McKeen Cattell, editor of SCIENCE and *The Scientific Monthly;* Dr. Leland O. Howard, principal entomologist, Bureau of Entomology, U. S. Department of Agriculture; Dr. John C. Merriam, president of the Carnegie Institution of Washington; Dr. Vernon Kellogg, secretary of the National Research Council, Washington, and Professor Harlow Shapley, director of the Harvard College Observatory.

These talks will be given by our leading scientific men and by visiting scientific men of international prominence. Each talk will be timely, and will include information of real news value. It is expected that many fundamental discoveries in all fields of science will first be announced to the public in this way.

AUSTIN H. CLARK,
Director, Press Service

THE JOSIAH MACY JUNIOR FOUNDATION

THE Josiah Macy Junior Foundation for preventing and curing disease and relieving human suffering has been established through a gift of $50,000,000 by Mrs. Walter Graeme Ladd, of Far Hills, N. J. The foundation was incorporated on April 23 in Albany, with Dave Hennen Morris chairman of the board.

The foundation is a monument to the memory of Mrs. Ladd's father, who died in New York in 1876. He was president of the Devoe Manufacturing Company.

Dr. Ludwig Kast, since 1906 professor of clinical medicine at the New York Post-Graduate Medical School, has been elected president of the foundation. He reports that the trustees intend to start work immediately on an outline of their course of action.

It is understood that the foundation will not limit its work to any particular field, but that it will probably lean most strongly toward development of methods to relieve the suffering of the mentally disordered.

In the letter accompanying her gift Mrs. Ladd said in part:

> It is my desire that the foundation in the use of this gift should concentrate on a few problems rather than support many undertakings, and that it should primarily devote its interest to fundamental aspects of health, of sickness and of methods for the relief of suffering.
>
> To these ends the foundation might give preference in

the use of this fund to integrating functions in medical sciences and medical education, for which there seems to be particular need in our age of specialization and technical complexities.

At the first meeting of the directors, held on April 22, the officers were elected as follows: Josiah Noel Macy, secretary of the board, a nephew of Mrs. Ladd and son of the late V. Everit Macy; Valentine E. Macy, Jr., treasurer, brother of Josiah Noel Macy. The executive committee consists of the president, the chairman of the board, Dr. James F. McKernon, the Rev. Samuel Trexler, Frederick J. Faulke. Marlborough Churchill, Lieutenant-Colonel U.S.A., retired, is executive secretary. The temporary offices are at 565 Park Avenue. Other members of the board are the Rev. Harry Emerson Fosdick, Chester H. Aldrich, J. Macy Willetts, Lawrence Morris, Professor John Dewey, Dr. Nellis B. Foster, Hamilton Hadley, Dr. Stewart Paton, of the Johns Hopkins University.

SCIENTIFIC NOTES AND NEWS

A MESSAGE has been received from Sir William Bragg, of the Royal Institution of London, accepting an invitation to attend the Ithaca meeting of the American Physical Society from June 19 to 21, and announcing the title of a paper for the meeting on "Faraday's Diary." The subject is a peculiarly appropriate one at this time, since Faraday's famous experimental researches in electricity, which formed the foundation upon which all modern electrical developments rest, were begun—at the Royal Institution—almost exactly one hundred years ago.

PROFESSOR G. H. PARKER, of Harvard University, is on his way to the University of Cambridge, England, where he will lecture during May. He will spend June and July visiting zoological laboratories in Europe and will return to America early in August.

AT the annual dinner of the National Institute of Social Sciences at the Hotel Roosevelt, New York City, on May 8, gold medals of the institute will be presented to Dr. George Richards Minot, professor of clinical medicine in the Harvard Medical School; to Anna Billings Gallup, curator-in-chief of the Children's Museum, Brooklyn, N. Y.; to William Lyon Phelps, professor of English language and literature, Yale University, and to Mr. Nathan Strauss, New York City. The presentations will be made by Dr. Michael I. Pupin, Dr. William B. Castle, Dr. C. Stuart Gager and Dr. Lee K. Frankel.

THE Faraday Medal was presented to Sir Ernest Rutherford at a meeting of the Institution of Electrical Engineers on May 1. The presentation preceded the twenty-first Kelvin lecture, delivered by Mr. R. H. Fowler, on "Some Recent Advances in the Electron Theory of Metals."

IT is announced in *Nature* that Dr. A. T. Doodson, associate director of the Liverpool Observatory and Tidal Institute, has been awarded a prize of £150 offered by the Royal Society of Arts in 1929, under the Thomas Gray Memorial Trust, for an improvement in the science or practice of navigation, for his work on the analysis and prediction of tidal currents.

THE annual dinner of the New York Alumni Association of the Johns Hopkins University was given on April 22 in New York City with Dr. Joseph S. Ames, president of the university, as the guest of honor.

DR. FREDERIC W. SIMONDS completed in February forty years of continuous service in the department of geology of the University of Texas, where he became associate professor in 1890.

THE honorary doctorate of science was conferred on April 17 at the annual class-day exercises of the Michigan College of Mining and Technology on Cornelius Francis Kelley, of New York City, president of the Anaconda Copper Mining Company; James MacNaughton, of Calumet, president and general manager of the Calumet & Hecla Consolidated Copper Company, a former member of the board of control of the Michigan College of Mining and Technology, and on William Kelly, of Iron Mountain, mining engineer, for many years chairman of the board.

ST. ANDREWS UNIVERSITY will, at the graduation ceremonial on June 27, confer the doctorate of laws on Dr. Owen Willans Richardson, Yarrow research professor of the Royal Society and professor of physics in the University of London.

THE doctorate of science will be conferred in June by the University of Durham on Dr. Frederick George Donnan, professor of inorganic and physical chemistry in King's College, London.

DR. KARL M. DALLENBACH, of Cornell University, has been appointed visiting professor in psychology at Columbia University for the year 1930–31.

THE following appointments have been announced

at Iowa State College: J. W. Woodrow, professor of physics at Iowa State College, head of the department of physics; Frank C. Vilbrandt, professor of chemical engineering at the University of North Carolina, professor of chemical engineering; Pearl P. Sanson, of Yale University, associate professor of foods and nutrition, and William B. Sarles, of the University of Wisconsin, assistant professor of dairy industry.

DR. C. C. BUNCH, associate professor of research otology in the Johns Hopkins Medical School, was recently appointed professor and head of applied physics of otology in the Medical School of Washington University, St. Louis. The appointment becomes effective on July 1.

THE following appointments in the department of zoology at the State University of Iowa have been made, effective on September 1. Dr. H. W. Beams, of the University of Virginia, assistant professor; Dr. H. Wright, of the University of Indiana, and Dr. G. Marsh, of the University of Texas, associates.

THE council of the Geological Society of America has voted to hold the next annual meeting in Toronto, from December 29 to 31. The following preliminary announcement is made of nominations for officers for 1931: *President,* Alfred C. Lane; *Vice-presidents,* Thomas L. Walker; Henry B. Kummel; Edgar R. Cumings (from the Paleontological Society); Alexander H. Phillips (from the Mineralogical Society); *Secretary,* Charles P. Berkey; *Treasurer,* Edward B. Mathews; *Editor,* Joseph Stanley-Brown; *Councilors 1931–1933,* Sidney Powers, Donnel F. Hewett; *Representative to the National Research Council,* E. H. Sellards. The Paleontological Society and the Mineralogical Society of America will hold meetings at the same time.

OFFICERS of the Michigan Academy of Science, Arts and Letters have been elected as follows: Dr. Eugene S. McCartney, editor of scholarly publications of the graduate school of the University of Michigan, *president;* Professor A. M. Chickering, of Albion College, *vice-president,* and Professor Leigh J. Young, *secretary.*

AT the annual general meeting of the Physical Society, London, held on March 28, the following officers were elected for the year 1930–31: *President,* Professor A. S. Eddington; *Secretaries,* Dr. Ezer Griffiths and Dr. Allan Ferguson; *Foreign secretary,* Professor O. W. Richardson; *Treasurer,* Mr. R. S. Whipple; *Librarian,* Mr. J. H. Brinkworth.

THE Ray Society, London, which met on March 21, elected the following officers: Professor W. C. M'Intosh was reelected *president,* Sir Sidney F. Harmer, *treasurer,* and Dr. W. T. Calman, *secretary.* Sir David Prain was elected a *vice-president* and Canon Bullock-Webster and Mr. C. H. Oakden new members of the council.

MR. S. M. KINTNER, director of the Westinghouse Research Laboratory, has been made assistant vice-president of the company.

EUGENE C. SULLIVAN, president of the Corning Glass Works, New York, has asked to be relieved of the presidency after service in that capacity since July, 1928. Upon his resignation he was elected vice-chairman of the board and will continue to be actively concerned in the policy of the company, particularly in research work.

DR. J. J. DURRETT, who recently resigned his position as chief of drug control of the Food and Drug Administration of the U. S. Department of Agriculture, returned to his former position on April 23. Dr. Durrett resigned to become state health officer of Alabama, and it was announced that Dr. F. J. Cullen would succeed him. It was later learned that Dr. Durrett upon reaching Alabama found the situation there unsatisfactory and on the initiative of Dr. Cullen his former position was offered to him.

THE Medical Fellowship Board of the National Research Council, of which Dr. G. Carl Huber, dean of the Graduate School, University of Michigan, is the chairman, met on March 29 and made the following appointments for the year 1930–1931: *Reappointments:* Eric G. Ball, Edwin Marshall Deery, Milton G. Levy, Ava J. McAmis, Leone McGregor, Charles Midlo and Bruce Webster. *New appointments:* James Bordley, III, Alexander Brunschwig, Jay Congor Davis, Norman E. Freeman, Wendell D. Gingrich, Minnie B. K. Harris, Richard W. Jackson, Carl E. Johnson, William B. Kountz, Salvatore P. Lucia, Margaret E. MacKay, H. Houston Merritt, Luther W. Oehlbeck, Robert A. Phillips, Charles E. Snelling, Teunis Vergeer, Frank H. Wiley and Alexander Zeissig. The next meeting of the Medical Fellowship Board will be held on October 4, and applications to receive consideration at that time should be filed on or before August 15.

DRS. E. D. MERRILL, A. B. Stout, J. H. Barnhart, H. A. Gleason, and B. O. Dodge have been delegated to represent The New York Botanical Garden at the Fifth International Botanical Congress, to be held in Cambridge, England, from August 16 to 23. Dr. Merrill is a vice-president of the congress and, with Director-Emeritus Britton, is also one of the vice-presidents of the section on taxonomy and nomenclature. Drs. Merrill, Stout, Gleason and Dodge will present papers. Dr. Barnhart is one of the four American representatives on the international *ad interim* committee on the nomenclature of plants.

DR. CHARLES H. HERTY delivered the annual lecture to the Sigma Xi Club of the University of Alabama on April 12, on "Chemistry and the South."

A THIRD meeting of the group of physics students from the colleges in the vicinity of Philadelphia was held in the hall of the Franklin Institute on April 14. The meeting was addressed by Mr. Morris E. Leeds, of Leeds and Northrup, who spoke on "Physics and the Making of Scientific Instruments," and by Professor Arthur H. Compton, of the University of Chicago, who spoke on "Physics and Research."

DR. LAFAYETTE B. MENDEL, Sterling professor of physiological chemistry in Yale University, gave an address on "Nutrition and Growth" at the annual conference of the American Society of Orthodontists in Nashville, Tennessee, on April 10. He also spoke to the students of the Vanderbilt University Medical School on the following day.

THE scientific symposium lectures, given each spring under the auspices of the Buffalo Society of Natural Sciences, Canisius College and the University of Buffalo, will be delivered on May 6, 7 and 8, by Dr. Charles E. St. John, of the staff of the Mount Wilson Observatory. The subjects of the lectures are: "Exploring the Sun's Atmosphere," "The Natural Constitution and Extent of the Universe" and "The Observational Status of the Einstein Theory."

THE fifteenth Guthrie Lecture of the Physical Society, London, was given at the Imperial College of Science, South Kensington, on April 11, by Professor P. Debye, of the University of Leipzig, who spoke on "The Scattering of X-rays in Gases in Relation to Molecular Structure."

DR. J. ARTHUR HARRIS, professor of botany and head of the department of botany in the University of Minnesota since 1924, and from 1907 to 1924 botanical investigator at the Station for Experimental Evolution of the Carnegie Institution of Washington, died on April 24. Dr. Harris was in his fiftieth year.

THE eighth International Congress of Photography will be held in 1931 in Dresden. It will convene on Tuesday, July 28, and adjourn the following Saturday, August 1.

THE seventh annual meeting of the Alabama Academy of Science was held at the Alabama Polytechnic Institute April 18 and 19, in the new Ross Chemical Laboratory.

THE joint meeting of the Eastern Section of the Seismological Society of America and the Section of Seismology of the American Geophysical Union will be held at the Bureau of Standards on May 5 and at Georgetown University on May 6.

THE University of Virginia announces the establishment of a summer biological station at Mountain Lake, Virginia. The station is on the shore of a natural lake which covers an area of approximately 250 acres, with an average depth of 60 feet. The lake is 4,000 feet above sea-level and is surrounded by mountains which rise several hundred feet high. The average temperature during the summer months is approximately 70°. In the first year seven different graduate courses will be given, three in botany and four in zoology. The first term is from June 23 to July 26, the second term from July 28 to August 29.

THE seventeenth field conference sponsored by the Oklahoma Geological Survey was conducted in Southwestern Kansas and Northwestern Oklahoma from April 10 to 13. The leaders were Chas. N. Gould, director of the survey, and H. L. Griley, a petroleum geologist. The problem was the study of the Permian red beds of that region. Visits were made to nine type localities of the Permian in Southwestern Kansas, first described by F. W. Cragin nearly forty years ago. These beds were traced southward for more than one hundred miles into Oklahoma, and studies were made of the changes in stratigraphy and lithology in that distance. The general conclusion arrived at in this area was that individual beds in the Permian are not continuous over wide areas, but that in almost all cases the beds are more or less lenticular. Eighty-two men were in the party. Discussions took place both in the field and at the night sessions.

THE *American Mathematical Monthly* reports that under the auspices of the Edinburgh Mathematical Society a Mathematical Colloquium will be held in St. Andrews, Scotland, from July 19 to 30. The following courses of lectures have been arranged: "Rational Curves and Surfaces," by H. F. Baker; "Arithmetical Properties of Curves and Surfaces," by H. W. Richmond; "The Wave Mechanics," by C. G. Darwin; "Elementary Mathematics from the Higher Standpoint," by H. W. Turnbull; "Recent Developments in Symmetric Functions, Determinants and Algebraic Equations," by A. C. Aitken; "Theory of Functions," probably by Professor G. H. Hardy; informal talks by Professor E. T. Whittaker and others with discussions on the lecture courses.

THE Royal Geographical Society will celebrate its centenary in October this year. According to *Nature* and the provisional program recently issued, the celebrations will begin on October 21, with the opening of the society's new lecture hall and other new buildings at Kensington Gore by the king or one of the royal princes appointed by him. Other events will include addresses on the history of the society, on the

history of exploration during the last century and on certain other aspects of geography. There will be a reception on October 22 and a centenary dinner on October 23.

THE London *Times* reports that on the eve of the departure of Professor Nicholas Roerich, the Russian painter and archeologist, for Central Asia it was announced that there had been founded a Himalayan Research Institute, or Roerich Museum, with headquarters in the Kulu Valley, Western Himalaya. The institute, which will cooperate with the American Archeological Institute, is an outgrowth of five years' work in Central Asia of the expedition led by Professor Roerich. Among its honorary advisers are Dr. Ralph V. D. Magoffin, president of the Archeological Institute, Mr. Roy Chapman Andrews, Professors R. A. Millikan, Albert A. Michelson and Alexander Klemin, Professor Jacques Bacot, of Paris, Sir Jagadis Bose, Dr. Sven Hedin, Professor Albert Einstein and Professor A. Geoffré de la Pradelle.

DISCUSSION

A PLEA FOR SANITY IN NOMENCLATURE

THE botanists of six continents are again preparing for another spasmodic effort to settle for all time their troubles with nomenclature. Preliminary discussions have been held, recommendations of all sorts made, committees appointed, excitement raised until the safety-valve is about ready to function, and next August all will be settled.

But will it? If history repeats itself, the trouble will be just as great five years from now as at present. Several codes of nomenclature have already been devised, beginning, if I am not mistaken, with that of Paris, in 1867, and all of them have been intended to produce stability in nomenclature. Instead of stability, every code has caused the change of many names and has induced stability only for those species about which there was no question in the first place. Botanists were content for a century with the good old name *Sassafras officinale* for our well-known sassafras, but the American Code compelled changing it to *Sassafras Sassafras,* and the latest, or International Code, turns it again into *Sassafras variifolium.* The red oak was known universally for more than a century as *Quercus rubra;* now that name is applied to a different species of oak and we are asked to call the red oak *Quercus americana.* Is that stability? No, it is merely legalized confusion. When one reads now about *Quercus rubra* he has no idea except from the context whether the southern Spanish oak or the northern red oak is meant. Codes of nomenclature have simply failed to give stability, and there is no prospect that any future code will be more successful in its aim.

The leading feature of every code is and has been priority. The oldest name shall be used, and the code merely decides how priority shall be judged, interpreted and applied in any specific case. In the last analysis, however, an adherence to the oldest name is not necessarily what we want; stability is the one desideratum, whether the accepted name is old or relatively new. Priority has been adopted as a means toward stability, but it has not given us the desired result. Under a rule of priority not one well-known specific name is safe against the possible discovery of an older one, except the names in the first edition of the "Species Plantarum," and even there we may find that we have applied Linnaeus's names wrongly, as was the case with the red oak, and feel compelled to displace them.

A scientific name consists of two parts, neither of which alone is the name of the plant. Yet we are required by all contemporary codes to bring together isolated halves of names and to construct new combinations which are to be valid, even though long antedated by other perfectly good names. It is undoubtedly proper, in combining two genera for taxonomic (not nomenclatural) reasons to bring the specific name into the genus, on the principle that half a loaf is better than none, but the displacement of an established name for this reason is folly. "Hold fast that which is good," as the apostle said. Yet the botanists of the world enthusiastically discarded the old Kew rule of considering only specific names proposed within the genus, which would have done away with all nomenclatural transfers and double citations, just as they also refused to accept the so-called Berlin rule that names not used for fifty years should have no nomenclatural standing. There are two principles, either of which would have tended toward stability, which botanists rejected. It appears sometimes that botanists do not want stability!

One of the greatest sources of confusion in names is caused by segregation of genera. Separation of a genus into smaller genera implies, naturally, that the segregator knows just what a genus is. On the contrary, it proves that a genus is not a biological entity, but merely a group of species, and that the prevailing fashion tends toward smaller genera, just as the prevailing fashion in dress, at least until this year, tended toward smaller skirts. But think of the trouble caused to the users of botanical literature by the segregation of many well-known genera! It is hard enough for the taxonomist to keep even with the so-called progress, and it must be impossible for the forester, the horticulturist, the pathologist and others who use plant names instead of merely playing with

them. If rules are to be adopted, and in this law-making age it seems impossible to avoid them, we should have a list, not merely of names to be conserved, but also of generic concepts to be conserved, so that such well-known economic genera as *Pinus*, for example, should not be segregated.

The Vienna Code has one good point (or bad point, if you prefer) of giving a long list of *genera conservanda*, names which shall be used in spite of the existence of other prior names for the same genera. That is a step forward toward stability, and the list should be greatly extended and an additional list of *species conservandae* added to it, but it has the weakness of not stating for what the names should be conserved. I know one such genus of six hundred species which must be so conserved; unfortunately the name rightly belongs to another genus of about forty species, so that the entire six hundred should, under the rules, get a new generic name. Don't be alarmed, brother botanist, I shall never make these six hundred new combinations, and I believe that any one who does should be shot without waiting for sunrise. In fact, I have suggested a standard species for this genus (privately, so that no name-maker's attention will be called to the wonderful possibility) which, if the principle of standard species is adopted, will conserve the name in its present usage.

All systems of rules call for priority in the choice of specific names, and if I find a long-forgotten or never-used name in some obscure book, I am supposed to drag it out, dust it off and introduce it to the long-suffering botanical public. If we are going to have rules, why not have also a list of conserved publications to serve as the sole basis of available names? The only real hardship entailed by such a system would be that some botanists would be barred from their favorite indoor sport.

Another interesting point is the use of Latin in describing species, as required by the International Code. Most botanists wish to publish their knowledge and make it available to the world at large and accordingly choose a language which will be intelligible to many readers. So the Czechs and Poles almost always publish articles of extranational importance in another language and the Russians generally add a résumé in French or German. There is a suspicion extant, however, that the taxonomists of one country, which shall be nameless here, wish a monopoly of the knowledge of their own flora, and will begin publication of new species in their own language unless deterred by rules. Maybe we had better insist, after all, on the use of Latin for specific diagnoses.

Laws are generally of no avail unless the law-making body has the power to enforce them. A weakness of all codes of nomenclature has been the lack of this power. As an example, nearly ten thousand new names have been published without Latin diagnoses since the promulgation of the Vienna Code. One eminent botanist once told me that he could enforce on the botanical public any code of names he wished, if he could publish a better flora than any other then available.

All these points go to show the weakness of nomenclatural rules in securing stability of names. Why then have any rules at all? Instead of a complicated code, always subject to change, always subject to disregard in one or more provisions by some botanists, always subject to differences of interpretation, let each botanist adopt the following principles (not rules) for his own work and follow them conscientiously, and stability of nomenclature will be as nearly assured as it ever can be: first, I shall not reintroduce, or insist on the use of, forgotten or nearly forgotten names; and second, I shall not change the scope of any group of plants unless I firmly believe that I am actually adding to our knowledge of plants thereby.

H. A. GLEASON

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TEST OF THE WEGENER HYPOTHESIS BY MEANS OF GEODETIC DATA IN INDIA

IN Vol. III of the Geodetic Report of the Survey of India for 1927 (published in 1929), are data which are of interest in connection with the Wegener hypothesis. Under the heading "International Longitude Project" is given a somewhat detailed account of the work done at Dehra Dun in 1926 in connection with the world longitude campaign. The statement is made that "the mean of these gives the final value of the arc Dehra Dun—Greenwich to be $5^h\ 12^m\ 11.^s794$. . . . The above figure may be compared with the old value of $5^h\ 12^m\ 11.^s770$, derived from the Indo-European telegraphic arc of 1894–96."

Under the heading "Computations and Publication of Data" is a statement regarding the variation of latitude which reads as follows:

> As a result of an enquiry from Professor Wegener, the values of astronomical latitudes, found at stations in India at which observations had been taken at more than one time, separated by considerable periods, were scrutinized to see whether they afforded any evidence of earth movement. The results are given in Table 2. They have not been cleared of polar variation.

A table showing the variation of latitude at a number of old stations is then given, after which occurs the following statement:

> Five sets of observations, at Mussoorie, Sangatpur, Harnāsa and Kundgol, cover intervals of less than a year each, in spite of which they show changes not much smaller than those of the others. Of the remaining stations, four out of five show increases in latitude between

1800 and 1870, and three out of six show increases between 1870 and 1927. The changes at Gogīpatri and Poshkar, which are situated 15 miles apart, are directly contradictory. It can only be concluded that all the changes may be attributed to errors of observation or of star place, and that there is no evidence of continental drift. Nor, on the other hand, is there any disproof of the existence of a drift of the order of fifty feet per century.

The latitude and longitude data for India indicate very clearly that there is no rapid movement of that country in a north and south or an east and west direction. There is no possible way to tell whether or not there is a very slow drift. It will take another century or more, with repeated astronomical determinations of latitude and longitude, to get any clear idea as to the stability or instability of the Indian region. It is interesting, however, to have the valuable evidence contained in the report from India.

WILLIAM BOWIE
U. S. COAST AND GEODETIC SURVEY

ANTAGONISM BETWEEN ZOOPHARMACOLOGY AND PHYTOPHARMACOLOGY

DR. DAVID I. MACHT has presented an interesting review of cases of the dissimilarity between the zootoxic and the phytotoxic action of various alkaloids and toxins.[1] To quote from his article:

> It has been the experience . . . that poisons produced by plants, or phytogenic poisons, are more toxic for animals than for plants, while poisons elaborated or produced by animals, or zoogenic poisons, are commonly much more toxic for living plant protoplasm than for living animal tissues.

It would be possible to extend this idea of an antagonism between animals and plants to the subject of diseases and their treatment. If we consider the bacterial diseases of animals as diseases in which a plant (the bacterium) is infecting an animal host, we find that these diseases are, as a general rule, virulent. The infecting organism does not show any compatibility with the host, and produces various highly toxic substances (the bacterial toxins) which circulate in the blood stream and very rapidly bring the disease to a crisis from which the animal either dies or recovers. In the case of recovery, we find a very marked protective reaction on the part of the animal host, as indicated by the production of various immunological substances, the antitoxins, bacteriolysins, agglutinins, opsonins, etc. The net result is either that the plant (bacterium) kills the animal, or that the animal kills the plant. We have, therefore, in this case, no compatibility between the two forms, but instead a marked incompatibility.

[1] SCIENCE, 71: 302–306, March 21, 1930.

When we consider the infestations of an animal host with animal parasites, we have a markedly different picture. The host and parasite live together without any marked protective or offensive action on the part of either. When death occurs in these conditions, it is a result of the gradual destructive action of the parasite on some particular tissue of the host. The tapeworm, the liver fluke, the malarial plasmodium, the trypanosome, the filaria worm, the spirochete and the intestinal ameba may be taken as examples of this type of infesting organism. These organisms do not produce any great amount of toxins, and do not stimulate the host to form any great amount of protective substance. The host and parasite are seemingly quite compatible, and live together in what might be called a semi-symbiotic relationship, until gradually the infesting organism produces enough organic damage to the host to interfere with normal function. These diseases are, therefore, of a chronic type as compared with the virulence of the bacterial diseases.

This antagonism between animals and plants is reflected in the treatment of our diseases. If we wish to cure a bacterial disease we either let the patient prepare his own defensive substances (let the patient get well), or we make use of the same defensive substances prepared by another host (the antitoxins). Ordinarily, treatment and medication are valuable only in so far as they make for the physical welfare of the patient. If we wish to cure our infestations with an animal parasite, we must make use of various plant extracts (quinine and emetine are examples), or resort to the preparation of synthetic chemotherapeutic agents. The patient is practically entirely powerless to cure the disease completely, although he may reach an equilibrium with the parasite, in which the disease is to all intents latent, but from which condition the disease may later flare up and the patient suffer a relapse.

We may, therefore, entrust the treatment of bacterial infections to the patient, the physician or the bacteriologist and immunologist, knowing that their efforts will be assisted by the natural antagonism between the host and the infecting organism. In the parasitic infestations, the host, the physician and the parasitologist can do no more than describe the disease. The cure of the disease must be sought for in the growing field of chemotherapy.

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TEREDOLITHUS, A NEW COLLECTIVE GROUP NAME

QUITE a number of fossil ship worms have been described under the generic name Teredo. Most of

these names were based upon fossil woodborings or the lining of burrows and occasionally upon shells. These parts without the pallets unfortunately do not furnish characters which are at present considered of prime importance in ship worm classification.

Recent studies of the living species have demonstrated that ship worms, like other bivalve mollusks, have restricted ranges, and this knowledge will undoubtedly be used by paleontologists in dealing with fossil species, which will result in the description of many new forms in the future.

Since the classification of recent species is now quite well established it seems a pity to burden the rather limited group Teredo with the many specific means which no one can at present place in their proper genus. It is for that reason that I now suggest the collective name Teredolithus for the reception of these generically indeterminate species of ship worms. This name is not to be considered a genus in the accepted sense, but a convenient repository for such species as we find at present generically indeterminable. This name is to have no type, and therefore continue in use as long as generically indeterminate ship worm species exist.

The splendid precedent for a somewhat similar procedure was established by Dr. Stiles in 1907, when he created the name Agamofilaria for the reception of species of Filarids based upon larval forms which failed to furnish the characters for proper generic designation. This group name has served and is still serving a useful purpose as a more or less temporary resting-place for immature Filarids.

Some of the American fossil ship worms which should be placed under Teredolithus are: *Teredo calamus* H. C. Lea, *T. circula* Aldrich, *T. dendrotestes* Brown and Pilsbry, *T. emacerata* Whitfield, *T. fistula* H. C. Lea, *Kuphus incrassata* Gabb, *Teredo mississippiensis* Conrad, *T. pugetensis* White, *T. simplex* Lea, *T. substriata* Conrad, *T. tournali* Leym. and *T. virginiana* Clark.

PAUL BARTSCH

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DISCOVERY OF PHOSPHORUS FIXING COMPOUND IN THE SOIL

THE Louisiana Experiment Station has found an iron compound in southern soils which is responsible for the fixation of phosphorus. In the poorly drained soils the compound exists as concretions, ranging in size from below the visibility of the naked eye to fine gravel. In the well-drained soils, the concretions are not so much in evidence.

The concretions usually consist of a series of smaller ones. They are black in color, and when wet are rather soft. The structure is very open, and when the concretions are placed in water they emit a singing noise due to escaping air.

The physical structure of the concretionary material is such that it forms a very reactive compound. It appears that the phosphorus in this compound occurs as a basic ferrous phosphate. Drainage apparently determines whether the basic ferric or basic ferrous phosphate occurs.

The solubility of this phosphorus compound is exceedingly low, about .2 ppm. PO_4 in a .002 N. H_2SO_4 acid solution. As the amount of PO_4 varies in this basic compound it is likely that the solubility also varies. The effect of saturating this compound with PO_4 on the solubility is being studied, as well as various other soil treatments.

A. H. MEYER

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THE BANANA IN EARLY BOOKS: FRUIT OR STEM?

IN a paper[1] published recently I made the statement that the banana, as known to-day, existed in India before the Christian era, but further examination of the evidence makes me less sure of that conclusion. The earliest record, Megasthenes (303 B. C.), refers to a banana, but speaks only of the pseudostem as being eaten. The frescoes of Ajantâ (400 B. C. to A. D. 700) show unmistakable banana plants, but a careful examination has failed to discover any pictures of the fruit, although the mango, lime, custard apple, aubergine and other fruits are clearly illustrated. It seems probable, therefore, that the stem and not the fruit of this banana was eaten. I had previously accepted Pliny's interpretation of Theophrastus' statements as probably referring to leaf, flower and fruit of a single plant but am now inclined to take a more literal translation. In that case only the second "Ετερον δέ οὐφὺλλον . . . ," that referring to the leaf, can positively be connected with the banana. Ibu Serabi says, "Musa. Abēmesuai ē calm ē medio primi grad' humidū ī fine eius nutrit par," and Ibu Sina, though using the name Musa, does not say whether the fruit or stem was eaten. It is not until 1563, with Garcia da Orta, of Goa, that I find the fruit of the banana definitely referred to as being eaten. I can not accept Rung's[2] evidence of its existence in pre-Christian Egypt as convincing, for his figures may represent hands of bananas but look at least as much like bundles of faggots tied together. The evidence of its existence in America is even less convincing. It seems evident that the Physocaulid bananas, *Musa Eusete, M. glauca,* etc.,

[1] Philip R. White, "Studies on the Banana," *Zeitschrift f. Zellforsch. u. mik. Anat.*, 7: 673–733, 1928.

[2] Richard Rung, "Die Bananankultur," in J. Perthe's "Geog. Anstalt," Bonn, 1911.

were known in North Africa, Asia Minor, India and perhaps America at a very early period but that the Eumusae were unknown in these regions until a much later date than we had supposed. I should appreciate any references that I have missed and especially any pre-Christian records from the Malay Peninsula, Siam, Cochin China or the East Indies.

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THE COLOR-BLINDNESS OF INDIANS

THE department of psychology of the University of Denver has begun a preliminary study of color-blindness of Indians. In the spring of last year (1929) we tested 390 Indians of the southwest with the Ishihara test for color-blindness, and found seven red-green blind, but none definitely totally color-blind. This is an incidence of not more than 2 per cent. Only one was a female. It is planned to visit numerous Indians of the central far west and administer the same test with the Nela test from the Johns Hopkins University during the spring and fall of this year so as to determine if the incidence of color-blindness among Indians is greater or less than it is among whites.

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THE PRESIDENCY OF THE BRITISH ASSOCIATION

IN the extract on the British Association from the London *Times*, reprinted in SCIENCE of April 4 (p. 354), it is stated "if General Smuts becomes president of the London meeting (in 1931) he will be the first president elected from one of the Dominions." It may be noted Sir William Dawson, of Montreal, was president at the 1886 meeting held at Birmingham.

A. F. HUNTER

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SCIENTIFIC BOOKS

Methodik der wissenschaftlichen Biologie. Edited by TIBOR PETERFI. Vol. 1, Allgemeine Morphologie, xiv + 1425 pp., 1 col. pl., 493 figs. in text. Vol. 2, Allgemeine Physiologie, x + 1219 pp., 358 figs. in text. Berlin, Verlag von Julius Springer. 1928. Price (bound), 198 marks.

A PARTICULARLY illuminating insight into the rate of progress in the biological sciences, a layout of their diversification and ramifications and a display of the dominant directions of biological developments can be observed in a comparison of the contents of Peterfi's recent monographic encyclopedia of methods of scientific biology with any book in the fields of methods, say of fifty years ago. The very word biology in the last half century has itself acquired new and wider meanings and has established itself beyond displacement by the quibbles of botanists and zoologists, followers of disciplines diverted from their common interests by the artificial jurisdictions of herbarium and museum. There is really only one biological science, though many avenues approach it. Both the diversity and divergences of these avenues as well as the unity of the science of biology are revealed in this encyclopedia of biological methods.

As an index of the shift in emphasis and selection in biological work now current, possibly some what distorted by editorial guidance, one notes that the entire subjects of botanical and zoological collecting and of museum and herbarium technique are restricted to 148 pages of the total of 2,644, which is less than the space devoted to the care of living plants and animals. There is less occasion for the inclusion of these subjects under "Allgemeine Physiologie."

No one person could possibly function as an expert, and scarcely even as a critical compiler of methods in so diversified a field. Hence Dr. Peterfi has associated with himself in this enterprise no less than forty-two other biological specialists, each of whom is responsible for one or more chapters in this work.

The first volume deals with general morphology, but in a more restricted sense than the extremely comprehensive "Handbuch" of Aberhalden which covers the entire field of the natural sciences. The aim has been rather to restrict the subject to, and to intensify the treatment of, those fields of the natural sciences which are more or less distinctly morphological or which impinge thereon. The first volume is therefore written for morphologists, botanical and zoological alike. It includes the basic methods of morphology, microscopy, the study of cells, tissues and of development.

The volume opens with a 200-page introduction to the mathematical treatment of biological problems by Professor A. Walther, with abundant illustrations of the applications of formulas and graphs to specific biological data. Professor A. Köhler discusses the optics of the microscope and Dr. H. Zocher the ultramicroscope.

The subject of general microtechnique is introduced by Fr. P. Vonwiller with articles on the use of direct illumination and on vital staining, by Dr. R. Keller on electrohistological staining reactions and by Professor G. Levi on tissue culture, while Professor T. Peterfi writes of micrurgie, or the study of cells with the micromanipulator; Professor G. C. Heringa writes

on the making of permanent microscopical preparations, and Dr. K. Belar on descriptive cytology.

The field of special microtechnique is somewhat unevenly broken up and developed under the headings of Protozoa by Dr. K. Belar, vital staining in plants by Professor E. Küster, permanent botanical preparations by Dr. H. Schneider, animal tissues and histochemical methods by Professor B. Romeis, cell pigments and lipoids by Dr. M. Schmidtmann and general and special methods in histochemistry by Professor G. Klein.

Methods in descriptive embryology, including collection, fixation, preservation and sectioning of embryos and the demonstration cavities and of vessels by injection and corrosion methods, are described by Professor E. Pernkopf. There is no treatment of the preparation of models from sections.

The final section deals with microscopical methods as applied to the skin, nervous system and sense organs of invertebrates and to several of the principal invertebrate phyla by Dr. J. v. Gelei.

The outstanding chapters in this comprehensive volume are those of Dr. Köhler on the theory and construction of the optical parts of the microscope, Dr. Peterfi's account of microdissection apparatus and Dr. Belar's discussion of the technique of cytology.

The second volume is assigned by title to "Allgemeine Physiologie." Possibly, since systematics are at present under the tabu of orthodox biology, the editor has conceded a place in the kindly shade of physiology [*sensu latu!*] to "Zoologische Musealtechnik" by Professor C. Zimmer and to "Botanische Museumskunde" by Professor J. Schiller, with "Herbarpflanzen" by Konservator Dörfler slipped in as an "Anhang," while the article by Professor P. Schulze on the collection of zoological material for investigation is permitted to devote all of two pages to vertebrates.

Continuing in the field of physiology, we find sections devoted to the maintenance and rearing of animals and plants, with chapters on fresh-water aquaria and terraria by Professor L. Müller, on sea-water aquaria by W. B. Sachs, on insects and insectaries by Professor A. Hase and on mammals by Professor H. Nachtsheim, while Professor E. Küster and Professor F. Oehlkers treat respectively the lower and higher plants.

The following section treats of photography, microphotography, cinematography, microcinematography and the technique of drawing. The last named, by Dr. K. Belar, is very helpful, though he omits mention of the exceedingly useful Wolff carbon pencils.

Methods in the study of heredity by Professor G. Just include the mathematical treatment of variation, a brief discussion of the analysis of individual characters and a very full account of methods in genetics in *Drosophila* and in man.

Developmental mechanics in plants is treated by Dr. A. T. Czaja and in animals by Dr. O. Mangold, including a most welcome account of the methods used in the study of external and internal factors, such as gradients, isolations, defects, combinations and transplantations, to which appendices on artificial parthenogenesis and cell stimulation are added.

A nearer approach to physiology is attained in the chapter on methods in aseptic operation by Professor H. F. O. Haberland, in the physiology of stimulation by Professor O. Koehler and of protoplasm by Professor J. Spek, on plant physiology by Professor E. G. Pringsheim, on electrometry by Dr. G. Ettisch, on the metabolism of cells and tissues by Dr. H. A. Krebs, on metabolism in plants by Dr. O. Arnbeck and on substance and energy changes in plants by Dr. J. Hirsch.

In face of the difficulties which arise from the dimensions of the fields covered, the inevitable omissions of desirable portions of the many fields and the obvious inequalities in the treatment of different subjects, the editor has succeeded admirably in producing a most useful encyclopedia of modern biological methods which every biologist will find exceedingly useful as a work of reference for methods in a wide range of biological investigations.

The current methods in German laboratories are to be found here with a moderate but by no means adequate account of those from other sources. There is a glossary of equivalent technical terms in German, English, French and Italian. The different subjects are extensively documented, but citations are largely drawn from German sources; for example, the closing chapter cites exclusively from such sources.

In these days of increasing specialization and of new developments a synthetic work such as this is both an aid to progress and a stimulus and a guide to endeavor.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN ELECTROMAGNETIC PUMP

DURING the course of some investigations in this laboratory, it became necessary to devise a pump which could be used to circulate sterile fluid in a system free from any rubber, metal, oil, grease or cement. To fulfil these requirements, a pump has

been constructed entirely of glass, in which the motion of the piston is actuated by electromagnetic forces.

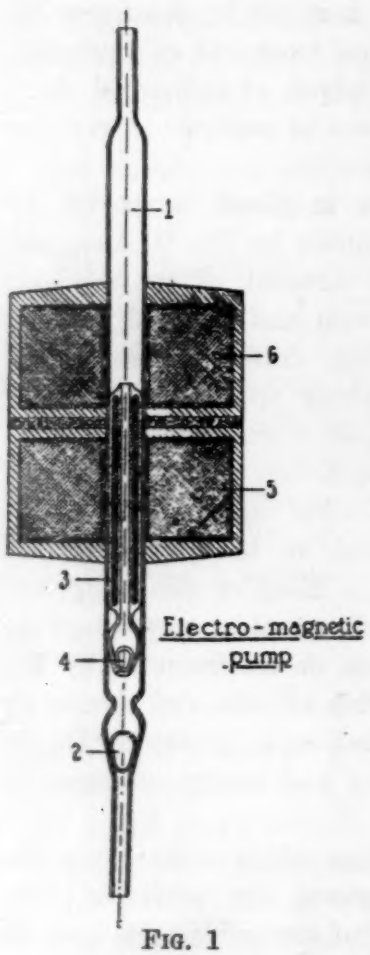

FIG. 1

The diagram shows the pump in cross section. The pump cylinder (1) is a glass tube which has a carefully ground valve (2) at its lower end. The piston (3) consists of two tubes with a soft iron core fused between them. The lower end of the piston has a valve (4) which is identically the same as the cylinder valve (2). Both valves close by gravity. The pump cylinder is surrounded by a lower solenoid (5) and an upper solenoid (6). Both solenoids are hooked up in separate circuits. By means of a three-pole, automatic, mercury switch actuated by a rocking device, the electric current flows through the solenoids periodically in such a way that they are switched on and off, one after the other, with an intermediate state in which both solenoids are magnetized for a short time. Thus, a magnetic field is created inside the solenoids. The center of this field travels up and down periodically.

The iron core inside of the piston is attracted into the center of the magnetic field. The piston moves up and down continually, like the plunger of any pump. The up-stroke of the piston opens the cylinder valve (2) and closes the piston valve (4), while the down-stroke closes the cylinder valve and opens the piston valve. By this means, any fluid can be circulated or transferred.

The pump has many practical applications, especially where it is necessary to maintain sterility. It can also be employed for blood, and for strong acids, alkalis or other dangerous fluids.

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A METHOD OF SECURING MARINE INVERTEBRATES

WHEN instructor in charge of Bryozoa in the course in marine invertebrates at the Marine Biological Laboratory at Woods Hole, Massachusetts, in 1918, Dr. C. L. Parmenter introduced the expedient of suspending microscope slides in racks from floats so as to be held below tide level and clear of the bottom near shore in the Eel Pond and outside in the harbor at the docks of the laboratory to become inoculated with Bryozoa colonies.

This method of securing young colonies of encrusting and stolonate Bryozoa, otherwise very difficult to study undisturbed or even to secure in any other way, has been continued and modified as occasion demanded by his successors in charge of this group. The writer, who is the present incumbent, learned of it from Professor D. B. Young when first succeeding to the group in 1926. During the past three summers the method has been used in securing young clean tunicate colonies and some solitary tunicates for class study. In addition young and very transparent Anomia individuals of varying sizes have been obtained in such condition that the heart-beat and other rhythmical activities may be very accurately observed and timed. Some study has been begun on the relation of these rhythms to varying temperatures and oxygen content of the sea water in finger-bowls in the laboratory. Some investigations have also been made on the early development of some of the encrusting Bryozoa so obtained. The transparent substratum is ideal for such studies. Material for class studies so obtained is more than satisfactory, but the uncertainty as to just what will turn up on the slides on a given day for study prevents its exclusive use as the basis for study of definite forms.

Among the animal species so obtained at different times and in some abundance were the following: Barentsia sp., Bowerbankia sp., *Bugula flabellata*, *B. turrita*, Schizoporella sp., Lepralia sp., Membranipora sp., Folliculina, Botryllus, Ciona, Hydroids, Microciona, Halicondria, Balanus sp. and Corophium, on the slides; and *Asterias forbesi* and *Arbacia punctulata* between them and inside the racks.

The following description applies to the racks now used and their methods of suspension.

Two pieces of wood 34.5 cm × 2.7 cm × 1.5 cm and two pieces 7 cm × 2.7 cm × 1.5 cm are fastened together to make a rectangular frame of 34.5 × 10 × 2.7 cm external and 31.5 × 7 × 2.7 cm internal dimensions. In the long sides of the rectangle so formed, in the interior face of each, and directly opposite each other, twenty saw-cuts are made to receive the glass micro-

scope slides of ordinary size (3″ × 1″). The two open faces of the racks are then covered with zinc wire screen of about 0.8 cm mesh fastened along both sides of one and one side of the other by staples which, in the latter case, act as hinges and enable the rack to be opened for insertion and removal of the glass slides. These slides are inserted in the racks while clean, and the racks are then strung in pairs about three feet apart on tarred fish-net cord and a brick or stone sinker attached about five feet from one rack of the pair. The cord is so wound around the racks as to keep them closed, when suspended, and retain the slides in place. These are then suspended one above the other from the under-side of the floats, used as docks for small boats, in such a manner that the lower rack of each pair does not touch bottom even at low tide.

Somewhat similar methods have recently been reported as used for obtaining preparations of Protozoa and Algae by Butcher,[1] Lloyd[2] and Nauman[3] in Europe, and the method appears to be of wide applicability.

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SPECIAL ARTICLES

DETERMINATION OF POLYMERIZATION OF SOME POLYMER FORMALDEHYDES BY X-RAY METHODS[1]

IN attempts to determine the molecular size of highly polymerized bodies (mostly assumed to be in the form of very long chains) by X-ray methods, only relatively small unit cells could be found. However, it was pointed out that this would not necessarily justify the assumption that the molecules were small, since a periodicity in a very long chain or the presence of molecules of varying chain length in one crystal could give similar experimental results. Thus, the controversy in regard to the constitution of polymers could not be settled in a definite fashion by X-ray analysis.

The experiences made in the study of polymerized formaldehyde (polyoxymethylenes) were of similar nature. Staudinger, Mie and Hengstenberg[2] and Hengstenberg[3] came to the conclusion that the molecular size of polyoxymethylenes could not be determined from X-ray methods. The absence of "inner" lines in the Debye-Scherrer diagrams made them assume that the structure could be represented as a lattice built up of CH_2O-groups exclusively and in a chain-like fashion. The residual groups which can be present and terminate the individual molecules are distributed at random throughout the crystal (different chain lengths) and do not cause any X-ray effects. If no residual groups are present the chain is extended throughout the crystal length. It must be emphasized, however, that no real proof for the existence of such chains is available from the X-ray standpoint. This interpretation of the X-ray results represents merely an adaptation to Staudinger's chemical conclusion.

[1] Contribution from the Department of Chemistry of the Johns Hopkins University; preliminary report.
[2] *Z. f. phys. Chem.*, 126: 425, 1927.
[3] *Ann. d. Physik* (4), 84: 245, 1927.

Contrary to these results the author found the presence of "inner" lines.[4] In the first experiments only one such line was observed, which when considered as first order gave a degree of polymerization of 4.

The repetition of the experiments some months ago proved beyond doubt the presence of "inner" lines, only fortunately enough several orders could be observed, giving thus a means to determine for the first time the true length of the molecules of a highly polymerized body.

The preliminary results obtained are as follows:

δ-Polyoxymethylene: The following orders of the basis were measured: fourth, fifth, sixth, seventh, eighth, ninth, twenty-fourth and forty-eighth. The structure is closely hexagonal, the c-axes or length of the molecule is 45.1 Å.U. Neglecting the residual groups, the number of formaldehyde groups in the chain becomes 24 as calculated from the density. The length of one CH_2O-group then becomes 1.88 Å.U., which is in perfect agreement with the approximate value of 1.9 Å.U. of Hengstenberg which was determined from a series of acetyl derivatives of polymer formaldehyde. As to be expected, the twenty-fourth and forty-eighth orders have considerable intensities.

γ-Polyoxymethylene, sublimed: The eleventh, thirteenth, fifteenth, seventeenth and sixtieth orders were measured. The structure is more distinctly pseudo-hexagonal only. The length of the molecule is 113.4 Å.U. There are 60 CH_2O-groups in the chain (again neglecting the residual groups). The length of one formaldehyde residue is 1.89 Å.U., which again is a perfect agreement. The sixtieth order has the expected strong intensity.

Paraformaldehyde (Eastman Kodak organic chem-

[1] R. W. Butcher, *Nature*, 125 (3147): 276, 1930.
[2] Ll. Lloyd, *Nature*, 125 (3142): 91, 1930.
[3] Nauman, *Ber. Deutsch. Bot. Ges.*, 37: 76–78, 1919.
[4] Emil Ott, *Helv.*, 11: 300, 1928; compare also G. Mie and J. Hengstenberg, *Helv.*, 11: 1047, 1928; Emil Ott, *Helv.*, 12: 330, 1929.

icals): The sixth, seventh, eighth, ninth and thirty-second orders are measured. Again the structure is pseudohexagonal only. The molecular length is 60.6 Å.U., containing 32 CH_2O-groups. The CH_2O-group again possesses the length of 1.89 Å.U. The thirty-second order is intense. The three X-ray patterns show also distinct differences in regard to the "outer" lines.

The δ-product was examined with Fe-radiation, for γ- and para-formaldehyde Cr-radiation was used. Additional orders are indicated in all cases. α-Polyoxymethylene and ordinary γ-polyoxymethylene also show a series of "inner" rings, which, however, could not be measured thus far. These lines are more diffuse, indicating a less uniform composition of the products. Additional investigations are under way. A full account will be published shortly.

These results give a definite proof for Staudinger's view of the constitution of polymer formaldehyde. It is proved that in highly polymerized bodies molecules of identical length may crystallize together. The molecule of such polymerized bodies may be determined by X-ray research, which is highly important since no other physical methods give such definite results.

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TURNING OF THE SPERM IN THE ACRIDIAN FOLLICLE

IN describing the spermiogenesis of a gryllid,[1] the author found in one species of cricket, *Nemobius fasciatus,* that first the nucleus and later the head are turned while elongating toward the open end of the follicles. The other species of crickets turn the head first toward the blind end of the follicle. Later these sperm turn in the follicle and enter the vasa efferentia, swimming with the head first. This phenomenon had not previously been described.

An examination of the literature revealed the fact that practically all the illustrations show the sperm forming with the head end toward the blind end of the follicle. This was particularly evident among the Acrididae, in which so many studies of spermatogenesis have been made.[2] The author therefore expressed the surmise that the sperm of grasshoppers turn in the follicle after they are formed.

This surmise he has confirmed by the study of many slides of fixed material. As the spermatids begin to elongate in the cysts all the nuclei move to the outer wall. In this stage the spermatids radiate out from the center. Later, as elongation continues, some of the heads move so that all point toward the blind end of the follicle. The elongation now continues until the head, and especially the tail, are very long. It is hardly thinkable that sperm could move any great distance with long flagella-like tails leading the way, and so the surmise was made that they turn in the follicle before leaving it. The following observations are believed to give evidence for this suggestion.

(1) In several specimens such elongated cysts contain clusters of heads which are still oval in shape. These are turned toward the blind end. Further toward the open end in the same cysts in a row beside the cyst wall are several heads all turned toward the open end. These were interpreted as having turned and being on the way to the open end of the cyst.

(2) In some very long follicles groups of heads lying around the periphery near the open end are headed in that direction. These are the sperm of a cyst which have completed the turning. In many cases these sperm are beside or in among degenerating cells—larger or smaller masses of mostly uniformly staining protoplasm. I suspect that these have to do with the nourishment of the sperm. The origin of these cells was not determined.

(3) Many of the much elongated cysts show, somewhere between the forming sperm and the open end, many tails which are plainly "looped." Sometimes these loops lie in the section. Others are cut in the curve part. In a few cases the heads are in this looped condition. Here is the point at which the turning or reversing is taking place. The number of tails (or heads) in the loops varies greatly in different specimens.

Some of the unturned heads have reached the elongated thread stage. Other sperm seem to turn while the head is still oval.

The details of the time, place and manner of the turning and relative phenomena are being investigated and will be reported on later.

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[1] W. J. Baumgartner, *Zeit. f. Zellforsch. u. micr. Anat.,* Bd. 9: 41, 1929.

[2] H. S. Davis, *Bull. Mus. Comp. Zool. Harvard Coll.,* 53: 59, 1908.

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